BASIC EXPLANATION OF COST OF QUALITY

COST OF QUALITY

What is the cost of quality? The traditional approach to this question has seen cost of quality as the cost of failure, or spoilage, or the effort required to bring material that does" not conform to requirements back to a state where the material is once again acceptable for use. The focus has been *on* scrap, rework, and repair, The data examined has encompassed the cost of the material, and the man hours required for disposition of material by manufacturing. Often the data is expressed as a percentage of direct labor, or in the case of the material, a percentage of total work center output value.

The approach described above is one focused purely on FAILURE. Such an approach falls short of identifying the true cost of quality for the organization, and more importantly, fails to support the need for multidisciplined evaluation of problems to find the true root causes of errors and to eliminate those causes. Failure costs are definitely a part of the cost of quality, but only one part.

The cost of quality is:

> "the cost of all efforts expended to find nonconforming output, react to actual failures, both internally and externally, and to prevent failures from happening in the first place".
>
> "costs expended in the effort to find non-conforming output are called appraisal costs".
>
> "the costs of actual failures themselves and their correction are called internal failure and external failures costs".
>
> "the costs of efforts designed to stop problems or failures from occurring in the first place are called prevention costs".

We will begin by looking at definitions of each of the primary categories of cost of quality.

Appraisal Costs

These are costs that anyone expends in an effort to judge the acceptability of output and to identify any instance of non-conformance. Key terms here are evaluation activity, measure, or audit. The emphasis is on compliance with quality standards and/or performance requirements for any "output" (purchase order, engineering drawing, circuit card, actuator, etc.).

Failure Costs

These are costs that are associated with activity required to evaluate and either correct or replace output that fails to meet established quality standards and/or performance requirements. The emphasis is on the decision regarding what to do and then the resultant action. Key terms are determine, disposition, rework, scrap, repair, reaccomplish, or correct.

There are two types of failure costs:

Internal Failure

These are incurred prior to final delivery of the specific output to the customer (internal or external customer) .

External Failure

These are incurred after final delivery of the specific output to the customer (internal or external customer) .

Prevention Costs

These are costs incurred through efforts to avoid nonconforming output from occurring in the first place. These include actions that occur prior to or during all phases of business activity. The key idea here is that these actions are aimed at ensuring activities will be done correctly before the activities actually take place. Thus , errors are prevented from happening in the first place.

Understanding the general concept of each category is important. First, knowing what costs fall under each category requires a clear understanding of what each category means. Second, the level of cost in each category can tell you a great deal about what kind of approach an organization has towards quality in general. Third, the relative size of each category, when compared to each other as well as to the total cost of quality, is again an indicator of possible courses of action needed to address quality issues in that organization.

Table 1-1 provides examples of the types of activities that can be found under each of the four main categories. Table 1-1 was taken directly from the American Society for Quality Control publication, “Principles of Quality Costs”.

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DETAILED QUALITY COST DESCRIPTION SUMMARY

1.0	PREVENTION COSTS
1.1	Marketing/Customer/User
1.1.1	Marketing Research
1.1.2	Customer/User Perception Surveys/Clinics
1.1.3	Contract/Document Review
1.2	Product/Service/Design Development
1.2.1	Design Quality Progress Reviews
1.2.2	Design Support Activities
1.2.3	Product Design Qualification Test
1.2.4	Service Design Qualification
1.2.5	Field Trials
1.3	Purchasing
1.3.1	Supplier Reviews
1.3.2	Supplier Rating
1.3.3	Purchase Order Tech Data Reviews
1.3.4	Supplier Quality Planning
1.4	Operations (Manufacturing or Service)
1.4.1	Operations Process Validation
1.4.2	Operations Quality Planning
1.4.2.1	Design and Development of Quality Measurement and Control Equipment
1.4.3	Operations Support Quality Planning
1.4.4	Operator Quality Education
1.4.5	Operator SPC/Process Control
1.5	Quality Administration
1.5.1	Administrative Salaries
1.5.2	Administrative Expenses
1.5.3	Quality Program Planning
1.5.4	Quality Performance Reporting
1.5.5	Quality Education
1.5.6	Quality Improvement
1.s.7	Quality Audits
1.6	Other Prevention Costs

2.0	APPRAISAL COSTS
1.1	Purchasing Appraisal Costs
2.1.1	Receiving or Incoming Inspections and Tests
2. 1.1	Measurement Equipment
2.1.3	Qualification of Supplier Product
2.1.4	Source Inspection and Control Programs
2.2	Operations (Manufacturing or Service) Appraisal Costs
2.2. 1	Planned Operations Inspections, Tests, Audits
2.2.1.1	Checking Labor
2.2.1.2	Product or Service Quality Audits
2.2.1.3	Inspection and Test Materials
2.2.2	Set-Up Inspections and Tests
2.2.3	Special Tests (Manufacturing)
2.2.4	Process Control Measurements
2.2.5	Laboratory Support
2.2.6	Measurement Equipment
2.2.6.1	Depreciation Allowances
2.2.6.2	Measurement Equipment Expenses
2.2.6.3	Maintenance and Calibration Labor
2.2.7	Outside Endorsements and Certifications
2.3	External Appraisal Costs
2.3.1	Field Performance Evaluation
2.3.2	Special Product Evaluations
2.3.3	Evaluation of Field Stock and Spare Parts
2.4	Review of Test and Inspection Data
2.5	Miscellaneous Quality Evaluations

3.0	INTERNAL FAILURE COSTS
3.1	Product/Service Design Failure Costs (Internal)
3.1.1	Design Corrective Action
3.1.2	Rework Due to Design Changes
3.1.3	Scrap Due to Design Changes
3.1.4	Production Liaison Costs
3.2	Purchasing Failure Costs
3.2.1	Purchased Material Reject Disposition Costs
1.2.:	Purchased Material Replacement Costs
1.:3	Supplier Corrective Action
3.2.4	Rework of Supplier Rejects
3.2.5	Uncontrolled Material Losses
1.1	Operations (Product or Service) Failure Costs
3.3.1	Material Review and Corrective Action Costs
1.3.1.1	Disposition Costs
).1.1.1	Troubleshooting or Failure Analysis Costs (Operations)
).1.1 3	Investigation Support Costs
3.3.1.4	Operations Corrective Action
1.1.2	Operations Rework and Repair Costs
3.3.2.1	Rework
3 3 2.2	Repair
3.3 3	Reinspection/Retest Costs
3.3.4	Extra Operations
3.1.5	Scrap Costs (Operations)
3.3 6	Downgraded End Product or Service
3.s 7	Internal Failure Labor Losses
3.4	Other Internal Failure Costs

4.0	EXTERNAL FAILURE COSTS
4.1	Complaint Investigations/Customer or User Service
4.2	Returned Goods
4.3	Retrofit Costs
4.3.1	Recall Costs
4.4	Warranty Claims
4.5	Liability Costs
4.6	Penalties
4.7	Customer/User Goodwill
4.8	Lost Sales
4.9	Other External Failure Costs

Table 1-1

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Appendix A contains other lists taken from various studies and publications. As mentioned earlier, understanding what costs fall under each category requires a clear understanding of what each category means. Careful study of the definitions given above and the information in table 1-1 and Appendix A should give the reader a good grasp of the basics. Note also that more detail is provided in the individual functional sections found in Chapter four of the handbook.

One word of caution: It is easy to become *overly* concerned about very precise placement of costs in the appropriate category. While a certain degree of accuracy is certainly important to avoiding the erroneous inflation or reduction of a given category, experience has shown that the number of controversial costs is usually small and that the danger of skewing the data is small. The best rule to follow is to go back to the basic definitions of the categories.

Let’s look at two examples. One might conclude that inspecting a problem area with the purpose of preventing defects from getting out is an example of prevention costs. Go back to the definitions. Prevention costs are incurred through efforts to avoid non-conforming output from occurring in the first Place. The inspection here is clearly finding defects after they have occurred. These inspection costs are appraisal, or costs incurred in an effort to judge the acceptability of output and to identify any instance of non-conformance. Remember the key terms: evaluate, measure, or audit.

Another example could be an organization which has found that a group of operators has been turning out excessive amounts of nonconforming output. The problem turned out to be a lack of clear understanding of requirements, so training was initiated. Isn’t the cost of training part of the failure costs, since the training is the corrective step resulting from the defects? Again, refer back to the definitions. Failure costs are those associated with activity required to evaluate and correct or replace output that fails to meet established quality standards and/or performance requirements. Remember the key terms: determine, disposition, rework, scrap, repair, reaccomplish, or correct. Once the defective output has been dispositioned, attention is turned to determining why the defects occurred in the first place and how to prevent them from recurring. The training is designed to do that and therefore it is a prevention cost, in line with the definition for the prevention category.

BENEFITS OF COST OF QUALITY

Now that the cost of quality categories are known and the various costs that are associated with each category are recognized, the value of having these costs can be discussed. A very important point must be made. Remember: the cost of quality is not an end in itself, but a means to an end. Cost of quality represents one of many tools available for use in improving the overall quality of the products that the Department of Defense buys for use by defense personnel. As a beneficial tool, cost of quality:

1. provides visibility into the total cost of ensuring requirements are being met.

2. points to problems in the quality program that are reflected in cost of quality category imbalances, or excessive costs in the non-value added areas of quality activity.

3. acts as a diagnostic tool at *lower* organizational levels in identifying problem areas.

4. allows judgments about the real thrust of a given quality effort from the perspective of "inspecting quality in" versus "designing and building quality in".

5. allows management to judge the effectiveness of corrective actions taken to eliminate root causes and improve quality.

Once cost of quality has provided the above benefits, other quality management tools can then be applied to work problems and develop solutions. A contractor cannot be expected to successfully eliminate causes for defective material unless he has good visibility into where his problems are. Assuming he is doing what is required under other contractual requirements, such as MIL-Q-9858A and MIL-STD-1520, his overall effort will now be significantly enhanced due to the benefits of having cost of quality data available. Let's examine the benefits and see how each is realized.

Benefit 1: Provides visibility into the total cost of ensuring requirements are being met. Experts in the field of quality today agree that the total cost of quality, expressed as a percentage of sales, averages between 15% and 30% for American Companies. If the reader is familiar at all with the traditional measures of scrap, rework, and repair, these numbers totaled as a percent of sales, are typically between 5 and 10%. Why the difference? Because scrap, rework, and repair only represent FAILURE COSTS, and more specifically, INTERNAL FAILURE COSTS. Appraisal and prevention costs, and external failure costs must be added in for a true picture of the cost of quality. Seeing these other cost categories is vital because:

> appraisal costs show what it costs to find the items that require scrap, rework, repair, or use as-is actions.
>
> prevention costs show what level of effort is being expended to avoid defective output, that is scrap, rework, or repair actions in the first place.
>
> external failure costs show what costs are incurred after the output is in the hands of the customer and it fails to meet customer requirements.

It should be obvious that seeing all the cost categories, in all functional areas, is the only way to know the true total cost of the quality effort.

Benefits 2: Points to problems in the quality program that are reflected in cost of quality category imbalances, or excessive costs in the non-value added areas of quality. Now that the total cost is visible, and particularly in view of why each category is important as described above, attention can be turned to the relative importance of each category, both to the total and to each other. Look at figure 1-1.

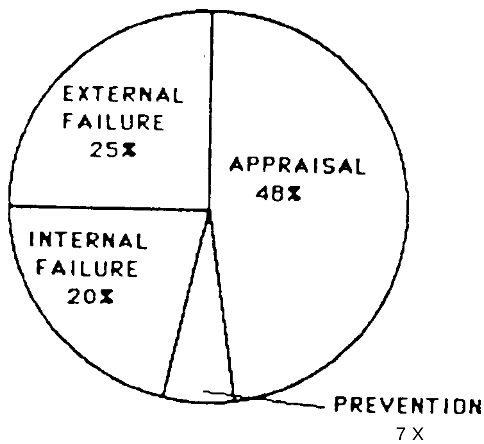


figure 1-1

Note that fully half the cost is incurred just finding defective output (appraisal). Just short of half is incurred in dispositioning the defects after discovery (failure). Only 7% is incurred in efforts to prevent defects from occurring in the first place. What does all this mean?

If this is a MIL-Q-9858A contractor, compliance with paragraph 3.6, which calls for "prevention and correction of defects" is clearly heavy on the correction side.

Failure costs are high as a percentage of the total because very little is being done to prevent defects from occurring.

If this is a MIL-STD-1520C contractor, multidiscipline action to determine and eliminate root causes for defects is not being effectively implemented.

For the Air Force analyst, a logical next step with this contractor would be to look at data on repeat nonconformances and overall defect level trends. Chances are excellent that the data would show:

high incidence of repeat nonconformances.

fairly stable, or flat trends, showing no real improvement over time.

The importance of cost of quality data should now be clearly apparent, particularly as an aid to point one toward other indications of quality activity in order to make judgments about whether the government is getting what is is paying for from the contractor's quality system. The contractor is being paid to find and correct defects and to eliminate the causes, so as to prevent the defects from recurring in the future. Further, prevention should be active up front, to prevent many potential defects from ever occurring in the first place. A contractor operating with relative costs of quality categories as shown in figure 1-1 will, in all likelihood, have a total cost of quality in the 15 to 35% of sales range.

Now look at Figure 1-2,

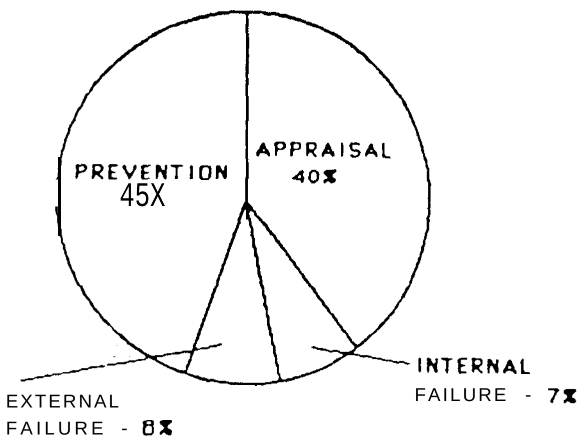


Figure 1-2

Note that almost fully half of the total cost is incurred in preventing defects from occurring in the first place or from reoccurring. Also note that as a percentage of the total, appraisal costs is 40%, not far from the percentage in figure 1-1. Does this mean the contractor in figure 1-2 is still inspecting in "quality"? The answer is no, for the following reasons:

- with the heavy emphasis on prevention (assuming it is an effective effort) defects are being avoided in the first place, and those that do occur are not repeating in the future.

- the appraisal effort is necessary to ensure that the prevention effort is indeed working as intended.

the low failure cost percentages would tend to indicate the prevention program is effective.

with this type of program, looking at data on repeat defects and defect trends over time will likely show very low repeats and excellent downward trends.

Although appraisal is at 40% of the total, a contractor with relative costs of quality as shown in figure 1-2 will usually have a total cost of quality in the 5 to 10% of sales range. In this case, the actual appraisal effort, and its associated cost, is much smaller compared to the effort in figure 1-1, · because the total cost of quality is lower.

As a further example of the above discussion dealing with figures 1-1 and 1-2, real data from The Tennant Company, a company that has successfully implemented a quality program oriented toward preventing defects *in* the first place, and preventing reoccurrence of defects that do occur, is presented *in* figure 1-3.

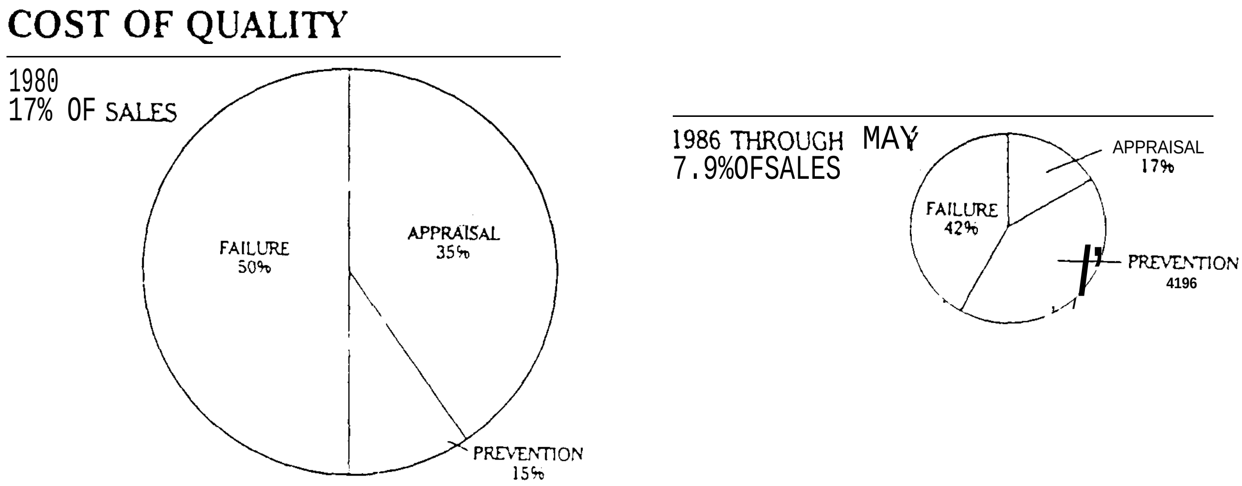


figure 1-3

Reprinted by permission, Tennant Company, "Quest for Quality",1987

Notice that as effort in prevention grew as a percentage of the total cost of quality, the total cost fell dramatically. Note also that appraisal as a percentage of the total fell. But this company expects appraisal to stabilize at about the original percentage of the total. This is because the quality organization in this company is now performing essentially an audit function to ensure everyone else's quality efforts are effective. The emphasis on everybody is important, and ties very well to the concepts of MIL-STD-1520C. A multidisciplined approach to analyzing the root causes of quality problems recognizes that many functions can and often do contribute to generation of defective output . Unless every potential contributor takes an objective look at where they could have done something to cause the defect, real identification and elimination of root causes cannot take place.

why does the emphasis on prevention result in lower overall cost of quality and better quality in the end product?

- preventing nonconformances occurs through good analysis of all "processes" and refinement of those processes so they produce little, if any, defective output.

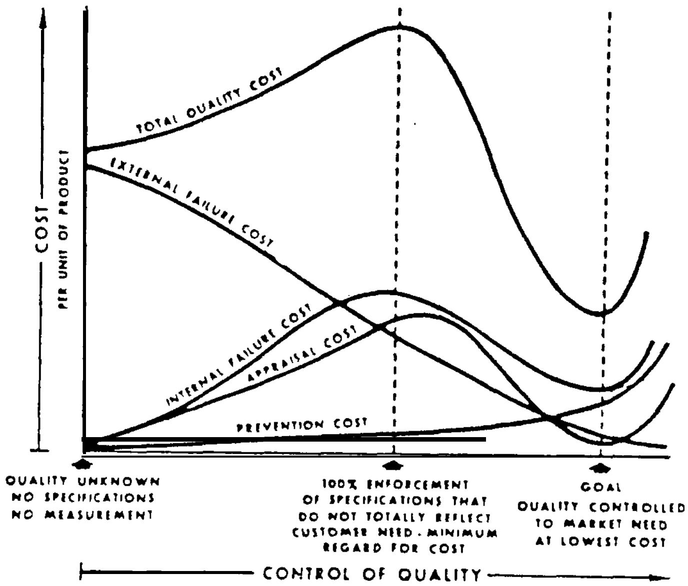
- once confidence is gained in "process" capability, less appraisal effort is needed to continue to verify process integrity.

- less nonconforming output is generated that requires disposition actions,

- less failures occur in the field due to nonconforming products.

As an illustration of what happens look at figure 1-4.

figure 1-4



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Notice that the 100% enforcement point reflects high appraisal and failure and overall total cost of quality, with low prevention. The goal is to optimize total cost of quality through that increase in prevention needed to eliminate defective output, such that failure and appraisal costs *are* minimized. Notice that external failure is low at the goal point, -thus providing the customer the best output possible.

<u>Benefit 3</u>: <u>Acts as a diagnostic tool at lower organizational levels in identifying problems areas</u>. Looking back at table 1-1 we are reminded of the large variety of individual cost elements that go in to each of the cost of quality categories. For example, under prevention costs in table 1-1 we find:

Operations (Manufacturing or Service)

- Operations Process Validation
- Operation Quality Planning
- Design and Development of Quality Measurement and Control Equipment
- Operation Support Quality Planning
- Operator Quality Education
- Operator SPC/Process Control

Consider a final assembly area for a complex mechanical product, such as a jet engine. The cost of quality for the area is again made up of the categories of prevention, appraisal, and internal and external failure. The costs at this level contribute to the overall totals for the company. Look now at figure 1-5.

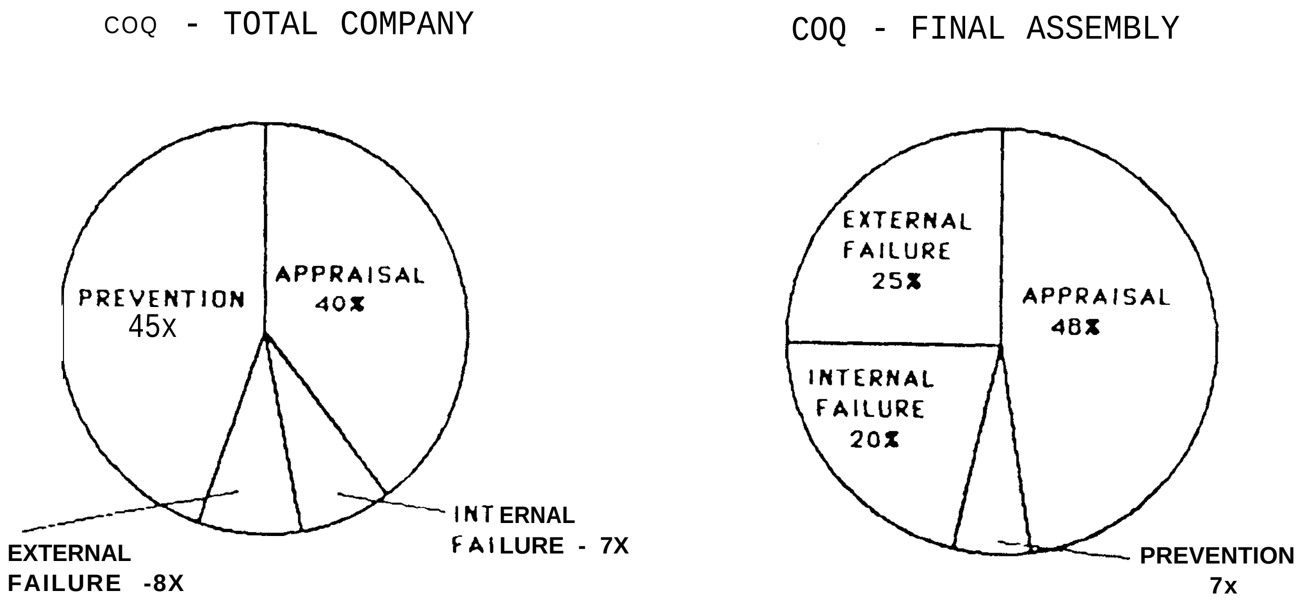

Figure 1-5

It is entirely possible for a lower level unit within the company to have cost of quality relationships that are significantly different from those for the total company, as shown in figure 1-5. The manager in final assembly should be concerned. It is obvious that a hard look is needed at what is being done in the area of prevention. Action should include looking at the cost elements listed above from table 1-1 for Operations, since final assembly is essentially the operation of putting the product together. The types of failures being found by the appraisal effort should also be examined to determine those that could be prevented by proper emphasis on the individual prevention cost elements, and more specifically, the prevention activity that generates those cost elements. Valid questions to ask are:

> What are the failures we are experiencing?
>
> Which ones are contributing most to failure costs?
>
> Why are they occurring?
>
> What prevention effort is underway to address these high contributors?
>
> Is current prevention failing?
>
> What are all the possible causes for these high contributors?
>
> What prevention action can be put in place to eliminate these failures now and in the future?

Once these actions are taken the manager can then move to benefit #5, having visibility into cost of quality, discussed below.

A word here about use of cost of quality data by top management is appropriate. Refer again to figure 1-5. If top management looks only at the total cost of quality and the relationship between the categories they are not going far enough. In the above example, looking at figure 1-5, Cost of Quality - Total Company, at the make up of the 45% prevention relative to each major function's contribution may reveal the following (figure 1-6).

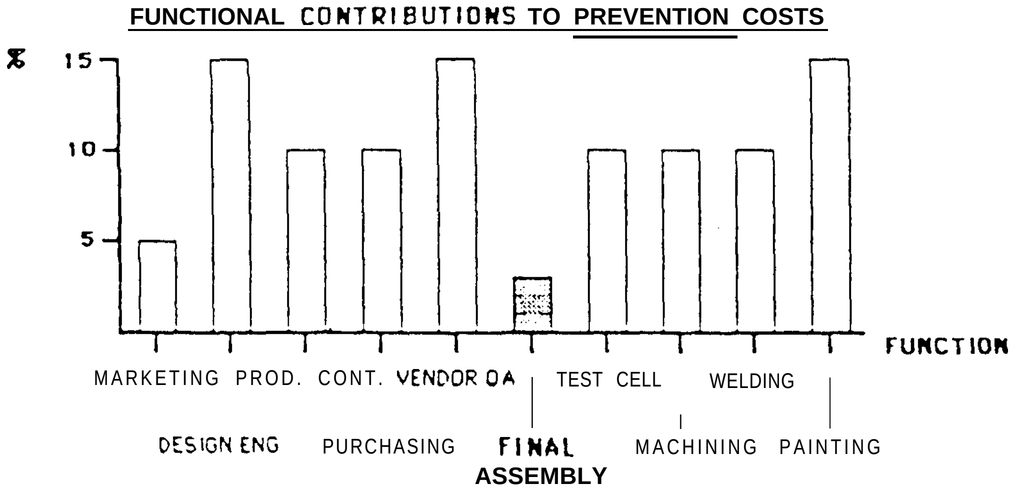

FIGURE I-6

Although prevention is 45% of the total cost of quality, final assembly is low relative to the percentage of contribution of the other functions. The next question to ask is, "What are the relative contributions to failure costs (figure 1-7)?"

FUNCTIONAL CONTRIBUTION TO FAILURE COSTS

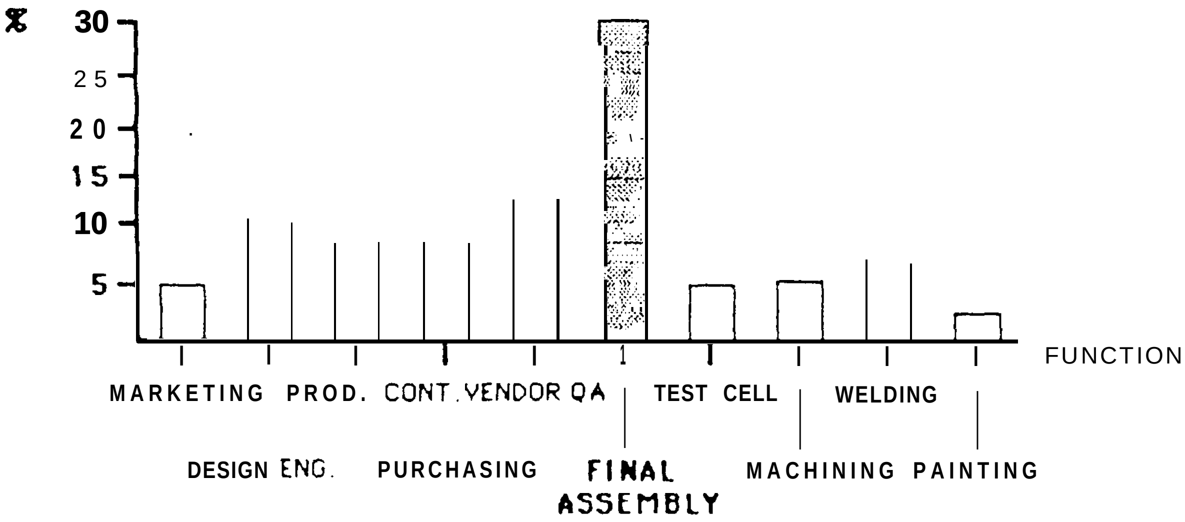

FIGURE 1-7

It is obvious that 30% of the total company failure costs come out of final assembly. In view of the lower effort in prevention and the high level of failure contribution, top level management should be looking to final assembly management to analyze the situation, take action, and report back.

There are a variety of circumstances that can and do dictate the relative relationships among functional elements and their contributions to cost of quality. The example is intended to make the point that management at all levels must use cost of quality data as a tool to help identify and solve problems.

Benefit 4: Allows judgements about the real thrust of a given effort to improve or manage quality from the Perspective of "inspecting quality in" versus "designing and building quality in". As discussed under benefit 1, the relative size of prevention and failure costs to each other and to total cost of quality can be used to determine the approach to quality being taken by a given company. When failure is very high and prevention low, then appraisal effort is mostly to find defective output, which is then dispositioned. On the other hand, when prevention is high and failure is low, appraisal is mostly to verify that prevention is indeed working. Appraisal of actual output can be reduced and the focus changed to audit of processes to ensure process integrity is maintained so that nonconforming output does not occur. (All processes, not only manufacturing processes.)

Benefit 5: Allows management to judge the effectiveness of corrective actions taken to eliminate root causes and improve quality. As discussed under benefit 3, once a manager has recognized that a problem exists by evaluating his cost of quality information, he can then monitor the effectiveness of any action taken to correct the situation by watching how his cost of quality reacts. The cost elements that go into his cost of quality should also be checked to be sure specific actions are taken (costs here increase) and that failures are being eliminated as a result of these specific actions (costs here decrease).

BASES USED IN COST OF QUALITY

Another important area to consider in a discussion of the concept of the cost of quality is the subject of the bases used for calculating cost of quality and for making judgments about what the costs mean. Any base chosen will vary in absolute terms over time as the level of business activity changes. Experience has shown that no matter what the base, expressing cost of quality as a percentage of that base has proven to be the most useful approach. Keep in mind that cost of quality is measured for two primary reasons. First, cost of quality helps to identify areas which need attention for making improvements. Second, once action to improve is underway, cost of quality provides a means of measuring the actual improvement achieved.

In deciding the bases to be used, a close working relationship is needed between the accounting, manufacturing, and quality departments. An easy way to start is for an organization to look at what bases are currently measured. One advantage of using this approach is that it requires no changes in the current accounting system. A second advantage is that using existing bases keeps the information on a footing that is already well established and understood within the company. Management often already reacts to these bases, so expressing cost of quality in these terms can make an impact on acceptance of the cost of quality numbers and the use of those numbers as management tool.

Bases that are frequently used include:

- total production costs
- net sales
- total purchased material costs
- total work center output
- direct labor hours
- productive direct labor
- shop - cost input
- contributed value

equivalent units of productive output

When a company selects the bases to be used, several important factors must be considered:

Are the bases sensitive to increases and decreases in production schedules?

If methods improvements through equipment modernization are achieved, will the bases be affected by lower direct costs?

Are they affected by normal fluctuations *in* sales?

Are they sensitive to fluctuations in the price of materials?

The matrix provided in **Table** 1-2 shows the applicability of these factors to each of the bases previously listed:

BASE FACTORS

	Sensitive to Prod. Sch	Moderni zation/lowe Direct Labo	seasonal Fluctuation	Materials Price
Total Production Costs	x			
Net Sales			X	
Total Purchased Material Costs				X
Total Work Center Output	X	X		X
Direct Labor Hours	x	X		
Productive Direct Labor	X	X		
Shop Cost Input	X			
Contributed Value		X		
Equivalent Units of Productive Output	X	X		

TABLE 1-2

Certain bases may be more appropriate for use in one area than in another. It is perfectly acceptable to use a different base among lower level cost centers. For example, production would be interested in, perhaps, internal failure costs as a percent of total production costs. Purchasing, on the other hand, may want to look at appraisal costs as a perCentage of total" pur-chased material costs . Engineering may want to consider prevention costs as a percent of design engineering labor costs. The base selected should be one that is a true reflection of what is being expended against the quality effort for that area.

As part of the development of this handbook, interviews were conducted with a variety of companies doing business with the government. Among the questions asked was "How are you expressing the cost of quality?" The overall results of these interviews are provided in Chapter 3, and Appendix D, but in terms of bases being used we found generally:

cost expressed as dollars
cost expressed as % of man hours
cost expressed as % defective
cost expressed as material cost in dollars
cost expressed as a % of sales

JUDGING THE MEANING OF COST OF QUALITY INFORMATION

A major problem for a government analyst in looking at cost of quality numbers is how to judge their meaning for an individual program. For example, is the company collecting cost of quality by department, by program, and by business unit, or only as a total? As shown in our example earlier, dealing with the total company versus the cost of quality for final assembly, it is very important for management to understand what goes into a company total, and for lower level management to understand what their unit contribution represents. The breakdown of contributions to the total cost numbers should be driven by a logical application of the structure of the organization. For example, see Figure 1-8.

EXAMPLE COMPANY STRUCTURE

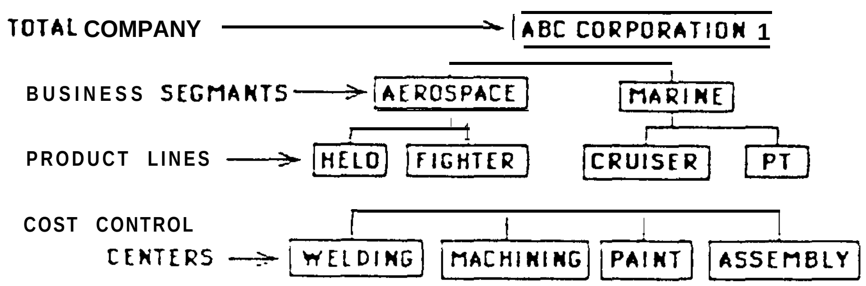

FIGURE 1-8

Understanding the contribution of each of the levels in Figure 1-8 to the total company cost of quality categories is important. Adverse trends, or unusually high cost at a lower level, may be masked when combined with all other cost center input. With this in mind, looking again at Figure 1-8, one could consider looking at, for example, internal failure for "machining" as a contributor to "Manufacturing" as a contributor to "Fighter", as a contributor to "aerospace", as a contributor to "total company" cost of quality (figure 1-9).

PULLING UP COST OF QUALITY CONTRIBUTION-THROUGH THE STRUCTURE OF THE COMPANY

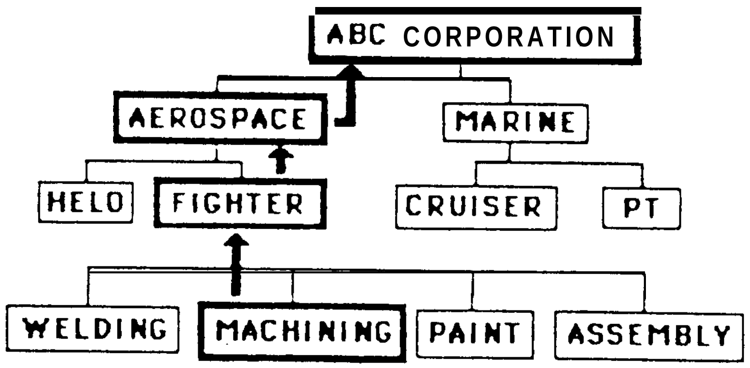

FIGURE 1-9

EVALUATING THE COST OF QUALITY

How do you know if the cost of quality is too high or too low, or just about right? Is there an "acceptable range" for cost of quality? Is continual improvement the real goal?

Recognize that at the producer there must be some cost of quality. Otherwise there would be no control over output and no measurement of whether that output met requirements. It would be Up to the user to prove the item's quality through actual use. If it performed as required and met all requirements, it would be judged a quality product. If it failed, it would not be judged a quality product. However, allowing for the user to find out whether the product is usable or not is not the way to determine the quality. The manufacturer must take some action to determine the product's acceptability before delivery. (See Figure 1-10).

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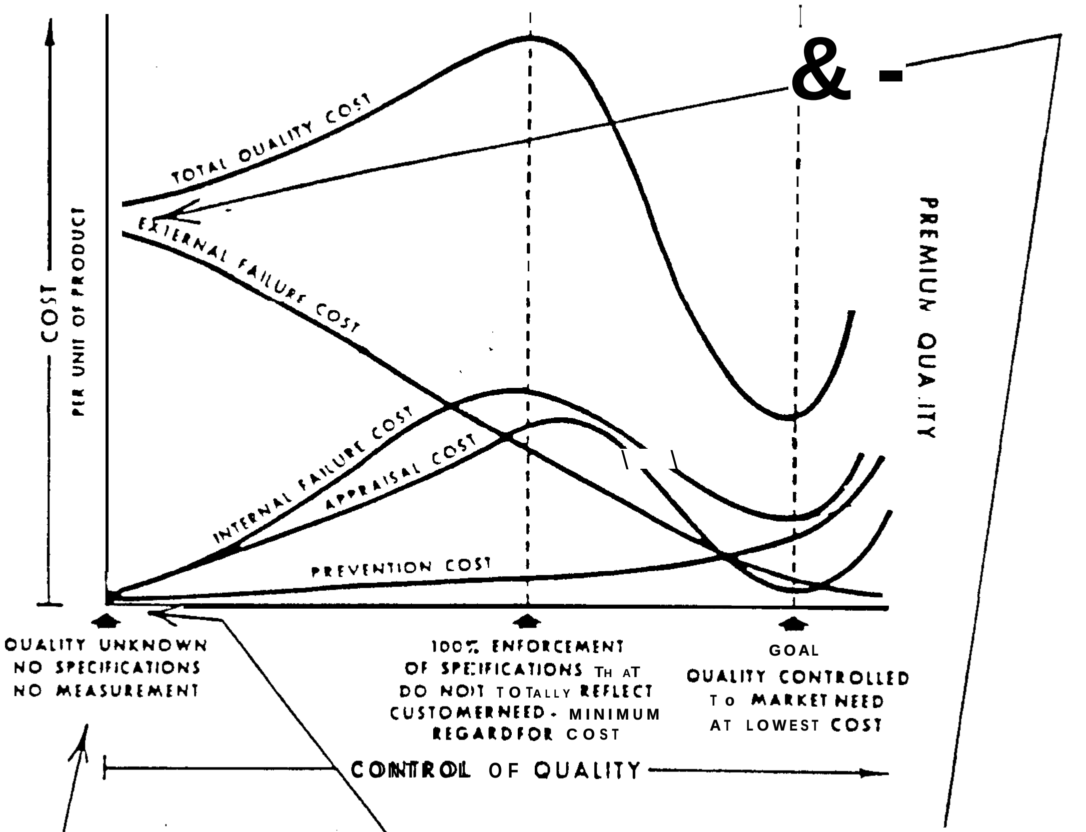


Product Posture

NO QUALITY PROGRAM

Cost of Quality
To Acquisition
Community

$0

Cost of Quality
To User
Community

$

Product Posture

NO QUALITY PROGRAM

Cost of Quality
To Acquisition
Community

Cost of Quality
To User
Community

excess O & M costs
- extra spares
- extra equipment
- extra people

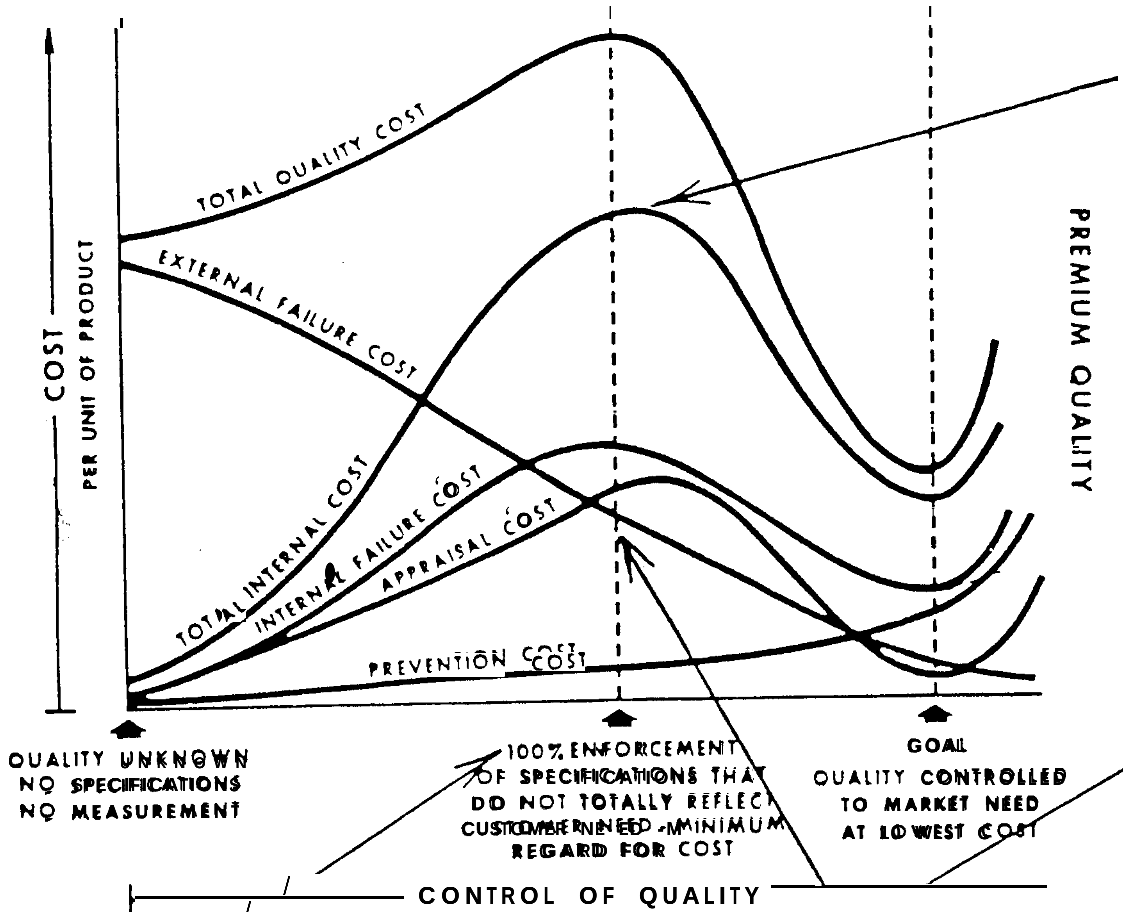
low operational ready rates

degraded mission effectiveness

Figure 1-10

It is obvious that if the manufacturer is going to expend resources to determine product quality there will be a cost associated with those resources. If the quality determination effort is eliminating field failures (other than normal wearout) then these quality efforts are satisfactory from the user's viewpoint. But how the quality effort is applied to eliminate field failures will determine to a large extent how much it costs. If the user is paying the bills, then the cost of quality is a factor in determining the end item price.

If the contractor is screening all products, at selected intermediate stages, as well as just before final delivery, and is finding and disposing of nonconforming items, then the production process is very inefficient. The process is producing defective products. If the producer knows this from experience gained through screening products, then allowances will be built in (in addition to the cost of actually <u>doing</u> the screening and disposing of the defects) for extra material, extra people, etc. , to accommodate the scrap, rework, and repair needed to correct/eliminate the defects. All this extra allowance adds to the cost of the final product. The buyer is paying for all the inefficiency in the producer's system. The producer may have an <u>effective quality program</u>, based on elimination of field failures, but not <u>an efficient quality program</u> because he is allowing inefficient processes to generate defects and is passing along in the cost of the product the costs of finding and fixing the problems. (See Figure 1-11).



Cost of Quality To Acquisition Community

Cost of Quality To User Community

$

Product Posture

FIND AND FIX QUALITY PROGRAM

$

paying for inefficiency in producers "processes"
- materials allowance for scrap
- consumables for rework and repair
- extra inspectors
- extra inspection equipment
- extra production people for rework
- extra people to support entire MRB program
  - engineers
  - quality technicians
  - clerks

extra time to redo *errors*
- engineering drawings
- purchase orders
- bids/proposals

"find and fix" does not prevent defects from reaching the field. Still some cost of external failures. High cost of internal failure.

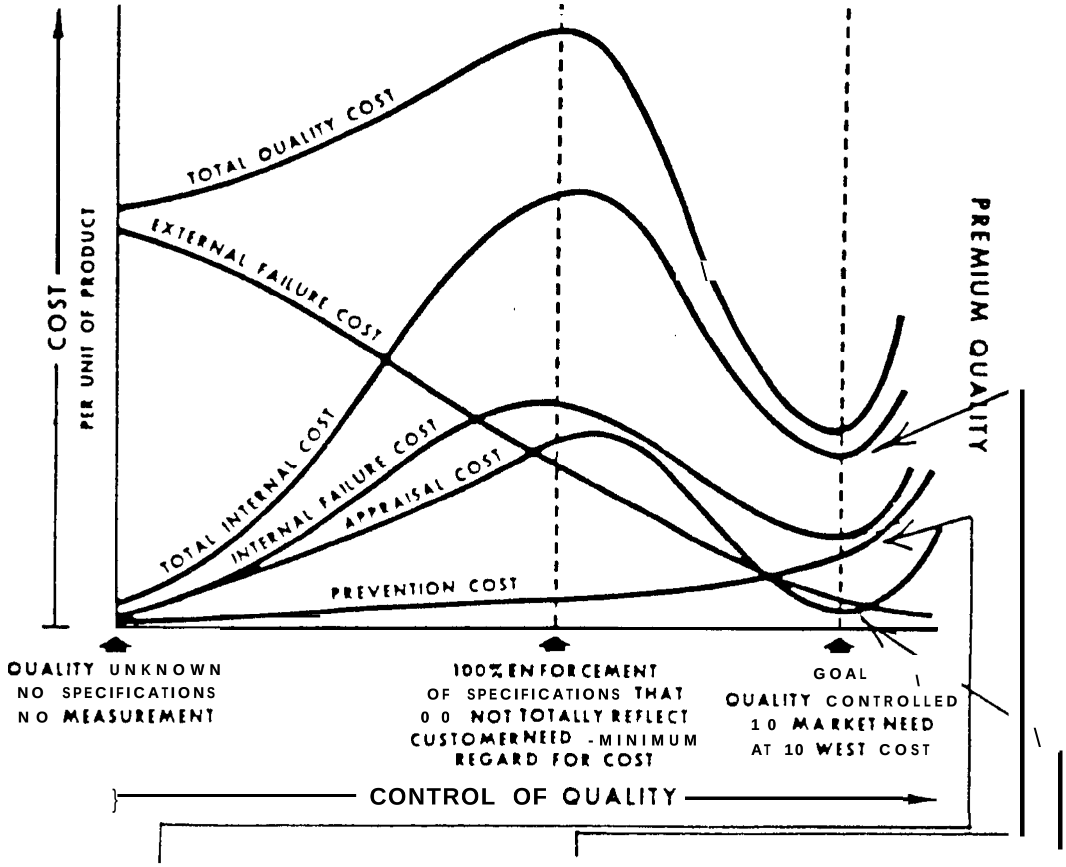
Figure 1-11

What is described above <u>only</u> addresses the readily visible costs associated with manufacturing. What about costs such as:

- drawing error correction
- engineering changes
- engineering liaison calls
- planning revisions
- redone purchase orders
- incomplete bid packages
- re-inspection
- re-test
- pre-review of defective material
- use as-is

All these are examples of costs associated with inefficient processes that are generating nonconforming output (engineering drawing; work instruction; purchase order) and require extra resources to correct or dispose of the nonconforming material. Once more, additional costs are generated and are passed on to the customer.

If the contractor is looking for nonconforming output and is taking steps to determine the real cause of these nonconformances, and further, is putting into place actions that not only eliminate the nonconformances, but prevent them from occurring, then he is attacking and eliminating the inefficiencies in his processes. Costs previously generated to accommodate the inefficiencies are greatly reduced or eliminated. The buyer is paying for a program that will result in <u>effective and efficient</u> production and on schedule delivery of a conforming product, and should not be paying for excess costs needed to support wasted resources. (See Figure 1-12).



<u>Product Posture</u>
Prevention Focused
Quality Program

Cost of Quality
To Acquisition
Community

Cost of Quality
to User
Community

The optimum situation.
Defects are <u>prevented</u> from occurring.
Defects that do occur are found, fixed, and <u>prevented</u> from happening again.
Assuming the design fulfills all user requirements, <u>reliability and maintainability</u> impact of defects getting to the field is greatly reduced.
cost of quality is low. System is both <u>effective</u> and <u>efficient</u>.

Figure 1-12

This all boils down to answering the following questions:

- Is the contractor's product failing in the field due to nonconformances?

- Is the contractor expending most of his quality costs in finding and fixing nonconformances before they reach the field?

- Is the contractor preventing nonconformances from occurring in the first place, and from recurring in the future?

See Table 1-3.